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THE SECOND ANNUAL MEETING OF THE SOCIETY FOR PLANT MORPHOLOGY AND PHYSIOLOGY.

ERWIN F. SMITH.

THE second annual meeting of this society was held in New York, December 27–29, in affiliation with the American Society of Naturalists. All of the meetings were held at Schermerhorn Hall, in the new and very commodious quarters of the Department of Botany of Columbia University. The Torrey Botanical Club gave a reception to the society and visiting botanists on Tuesday evening, and throughout the meetings the New York botanists did everything that was possible to make the occasion pleasant and profitable. Five papers listed on the programme were not read owing to the absence of the authors, some of whom were detained by sickness. There were, however, more than enough papers to fill the allotted time, and the second meeting of the society closed as successfully as the first one. Professor Macfarlane was elected president for the ensuing year. The following additions were made to the membership of the society: Newcombe, Pollock, Underwood, Waite, Stewart, Halsted, Johnson. In addition to the papers abstracted below, Dr. W. G. Farlow, as retiring president, gave a very interesting address on Peculiarities of the Distribution of Marine Algæ in North America, and the secretary of the society, Dr. W. F. Ganong, gave a ten-minute address before the whole body of naturalists on Advance in Methods of Teaching Botany. Dr. Ganong's address was printed in *Science*, January 20. It is to be hoped that the president's address may be printed in full. Two of the statements in it which impressed the writer most were: (1) the gaps which still exist in our knowledge of the marine algæ, especially in Floridian and Pacific waters, and (2) the algal desert which extends along our eastern coast from New Jersey to South Carolina. The statements given in the abstracts were, for the most part, furnished by the authors of the papers, the writer having simply put the abstracts into a condensed and coördinate form, with here and there an addition from his own notes.

PROF. JOHN W. HARSHBERGER: *Some Morphological Structures in Paulownia imperialis.* — *Paulownia imperialis* is a Japanese tree of umbrageous habit which thrives well and suckers freely in the neighborhood of Philadelphia and farther south. Its method of branching is sympodial. The main shoot, or leader, is terminated by an inflorescence. After the fruit is formed, and the seeds are discharged, the axis of inflorescence dies back to the point where the lateral bud is given off which develops into the leader of the next season. Beneath this shoot two other branches are also formed, which in succeeding years branch in the same way as the leading shoot.

This tree flourishes in Japan in valleys and on the sides of hills exposed to the powerful action of the sun. A study of the leaf structure shows that the plant has adapted itself to that kind of environment, branched, antler-like, interlocking, protective hairs occurring on the lower foliar surface.

The flowers are arranged in clusters of cymes, which approach the scorpioid type. The flower buds are protected by five thick sepals, which are covered with ferruginous protective hairs. The flower parts inside of the young buds are all well formed. The pollen is fully formed, as likewise the pistil. In the mature pod, which splits to discharge the seeds in December, there is found a fleshy placental disk rich in tannin, which may be either a reserve product or a waste substance.

In the petioles of the foliage and sprout leaves a number of different shaped crystals are found. These are all calcium oxalate, the difference in form being due to the different metabolic influences existing at the time of their formation. Peculiar refractive granules, the nature of which is not fully determined, are also found in the mesophyll cells of the leaves.

DR. W. F. GANONG: *On the Life History of Leuchtenbergia principis.* — This paper gave a synopsis of the author's studies upon the ontogeny of this rare and highly specialized species, the most noteworthy of the Cactaceæ. The paper traces the history of knowledge of the species, its systematic position, anatomy, morphology, etc. Its geographical distribution, habits and ecology, morphological composition as determined by comparative anatomy and ontogeny, and the internal anatomy and its development are treated in full. This is intended by the author as the first of a series of life histories of important species of this family which are expected to yield data for a better understanding of principles of morphological modification under the influence of changing ecological factors.

This plant, which lives under arid conditions, represents the extreme of specialization along the Echinocactus line, as is clearly indicated by its embryology. It has a highly differentiated anatomy, the tracheid system being better developed than in any other plant known to the author. The mamillæ show three concentric rings of vascular bundles, a cortical ring, a ring leading to the spine system, and a central ring going to the flowers.

PROF. BYRON D. HALSTED: *Root Tubercules upon Spring and Autumn Grown Legumes.* — The ninth successive crop of wax beans upon the same plot (one-twentieth acre) grown in the spring of 1898 consisted of plants, the roots of which bore numerous large, nearly spherical tubercles. The plants of the succeeding crop grown in the summer upon the same soil had very few of the root galls.

The cause of this remarkable difference in the behavior of the same variety of leguminous plant in the same germ-laden soil must be ascribed to changes in soil conditions. During the early growth of the spring plants the soil was considerably cooler than in August, when the second crop was passing through the initial stages of development. There was, doubtless, aside from the different temperature of the soil, a wide difference in the amount of available soil nitrogen, it being much less in the comparatively cool earth of May than in the warmer ground of August.

The nitrifying germs of the soil, being more active in midsummer, provided a daily supply of combined nitrogen for the young growing plants. On the other hand, the spring crop, not having this ample supply was "nitrogen-hungry," and this furnished the proper condition upon the part of the host plant for the abundant development of the tubercles.

Successful inoculation of the plants with soil-extract or the pure culture of the tubercle germ "Nitragin" is dependent largely upon soil conditions, and many widely varying results may here find an explanation.

FRANCIS E. LLOYD: *Further Notes on the Comparative Embryology of the Rubiaceæ.* — The genera studied include Houstonia, Rubia, Sherardia, Vaillantia, Crucianella, Galium, and Asperula.

The Nucellus arises as a papilla, at the apex of which develop, in the hypoderm, about eight or ten macrospores which elongate, and many of which commonly germinate, reaching a quadri-nucleate condition. One (sometimes two) becomes the perfected embryo-sac, which in all forms studied has antipodals, a hitherto unrecognized fact (excepting in Houstonia). One of the antipodals is very large, comprising the whole lower half of the embryo-sac (Sherardia, Rubia, Galium). The condition in Asperula is not completely cleared up, but the material studied indicates that a larger number of antipodals are present, approaching in this respect certain Compositæ.

The pro-embryo has a suspensor which is divided into two regions, the micropylar and the embryonal. The latter is composed of disk-shaped cells; the former of large cells which are swollen out laterally, forming absorbing organs which become applied to the endosperm. A free preparation of these structures resembles a bunch of grapes, a condition similar to that described for Sutherlandia by Hofmeister and Guignard.

The integument becomes absorbed by the endosperm till only the outer layer of cells is left. The seed covering then consists of the pericarp and a single layer of cells derived from the integument.

CHARLES H. SHAW: *The Inflorescences and Flowers of Polygala polygama.* — In this plant the author has discovered a third set of inflorescences, namely, *green cleistogamic flowers, produced in late summer on geotropic aerial shoots.*

In the conspicuous pink-purple blossoms the style terminates in a dense hairy tuft, bearing the stigma as a lateral knob. The embryo sac is generally imperfect and the seed abortive.

In the underground cleistogamic flowers the wing-like sepals are reduced to the size of the other three, the two lateral petals are wanting, the stamens have decreased to six, five, four, three, or two, and the style and hairy tuft are reduced to the vanishing point, leaving the stigma closely sessile. On the other hand, they are more highly developed in at least two points, namely, the walls of the microspores are *exceedingly thick*, and the ovary is densely covered with *glandular hairs.*

The newly discovered aerial cleistogamic flowers furnish transition stages between these two sharply marked types. The style is better developed, and there are rudiments of the lateral petals. In the thickness of the microspore walls and in the structure of the pistil especially interesting connecting stages are found.

The cleistogamic flowers of both sorts produce more seeds than the conspicuous ones.

R. E. B. McKenney: *Observations on some Monocotyledonous Embryo-sacs.* — The development of two species of Scilla, *S. hyacinthoides* and *S. campanulata*, was described and reference made to the development of other Monocotyledonous Embryo-sacs. The archesporial cell is formed from a sub-epidermal cell. This cell grows rapidly and a small cell is cut off by a periclinal wall — the primary tapetal cell. The primary tapetal cell divides later by a periclinal wall, thus giving rise to an inner and an outer tapetal cell. The archesporial cell continues to grow and divides twice, giving rise to three cells. The upper one of these cells remains uni-nucleate, the lower becomes tetra-nucleate, and the middle one develops into the embryo-sac with its eight nuclei. It seems probable that each of the eight nuclei of the embryo-sac, as well as the four in the cell below, represents a macrospore. Hence, the embryo-sac may be considered as two sporocytes which never develop the separating wall. On this hypothesis, the cell above the embryo-sac and also the one below, each represents a sporocyte. Two cases in which such a partition in the embryo-sac has been observed were mentioned, one by Mann in Myosurus, and one by the writer in *Lilium candidum*. Especial attention was called to the extra-nuclear origin of the spindle fibres and to the entire absence of centrosomes. The author has slides made from *Lilium tigrinum* and *L. candidum*, which exactly confirm Mottier's statements as to the origin of the spindle in Lilium.

R. E. B. McKenney: *The Structure and Function of Crystal Cells in Sensitive Plants.* — The crystal cells in sensitive plants form a complete sheath around the bundle cylinder in stems and a half sheath around the bast of the leaf bundles. Each cell contains a single large crystal. These crystals usually have the shape of a hexagonal prism. Each one is imbedded in apparently homogeneous cytoplasm. The nucleus is very small and homogeneous, but a nucleolus is wanting. Sap vacuoles and starch are also absent. From tests made with hydrochloric acid, nitric acid, caustic potash, fluoric acid, etc., it seems probable that these crystals are very insoluble silicates. They are found in the ash after burning the plants. These silicate crystals are entirely wanting in the cotyledons and only make their appearance in the first leaf after it has been expanded for a day or two. The crystals are first found in the cells of the sheath at the distal ends of the main bundles of the leaf as small spicular bodies. These gradually grow and assume the adult shape, but as they grow the nucleus becomes gradually smaller until it reaches its minimum size. Beginning with the cells at the distal end of the bundles, the crystals are developed in basipital fashion along the entire course of the bundle. The same course of development takes place in the bud leaves of old plants, only the crystals are fully formed before the leaf expands. These crystals were observed in several species of Mimosa, Acacia, and Oxalis. From the researches of Dutrochet and others it *seemed* as though the phloem was the region for the transmission of stimuli. However, since the crystal cells are closely applied against the phloem, and since they are best developed in the most sensitive plants and most poorly in least sensitive plants, it seems more probable that these cells constitute the *main* lines of transmission of stimuli. This tissue leads straight down to the pulvinus, but there are no crystals in the latter.

AMELIA C. SMITH: *Structure and Parasitism of Aphyllon uniflorum.* — The most conspicuous features of this plant are its parasitism on *Aster corymbosus* and the degradation attendant upon its parasitic habit as expressed by: (1) Absence of chlorophyll; degeneration of true leaves; loss of root hairs, and probably of root cap; reduction and degeneration of the bundle system, and relatively greater development of the phloem than of the xylem; small size of seed, and primitive embryo developed within a mass of tissue which is probably precocious endosperm. (2) Infrequence of stomata. Where present they are on the more exposed places, *i.e.*, outer surface of upper bract-leaves, upper part of flower stalks, and outer surface of calyx and corolla. (3) Abundance of starch. Starch is present in great quantities in root, stems, leaves, and carpellary tissue.

Sieve tubes seem to be entirely absent from the stem. The embryo is simply a mass of undifferentiated cells, *i.e.*, it is not distinguishable into cotyledons, plumule, and radicle. The use of the starch is problematic. The quantity stored in the endosperm is infinitesimal compared with that stored in other parts of the plant.

DR. M. A. HOWE: *On the Occurrence of Tubers in the Hepaticæ.* — The existence in this group of plants of tubers serving for vegetation propagation seems to have been, until very recently, almost unknown to plant morphologists. There are, however, four or five species, mostly of the genus Anthoceros, in which the occurrence of tubers has long been known to systematists. This number has been recently increased until, at the present time, at least eleven species are known in which tuber-like growths occur. Of these, four belong to the genus Anthoceros, three to Riccia, two to Petalophyllum, one to Fossombronia, and one to Geothallus. It is to be expected that as the hepatic flora of the drier regions of the earth comes under more extended and accurate investigation, this evident adaptation for carrying the plant over a season of drought will be found to be much more common than has been generally supposed.

In the Californian *Anthoceros phymatodes* the tuber appears as a swelling near the apparent apex of the more or less well-defined costa of a Thallus-segment, becoming soon strictly ventral through the continued onward growth of the segment, and coming at the same time to be pendant from the ventral surface through the formation of a fleshy or slender and elongated peduncle. Tubers are globose or ellipsoidal in form, 0.25 to 1 mm. in diameter, at first smooth, but becoming at length thickly covered with root hairs. A cross-section of the body of the tuber shows it to consist of a cortex of 2 to 4 layers of nearly empty cells enclosing a central mass of smaller cells so densely filled with oil drops or with merely colorless granules that the cell boundaries in a section are rendered obscure. There is very little if any starch. In two cases, old tubers of *Anthoceros phymatodes* were found sending out new shoots, demonstrating that they play a part in the vegetative propagation of the plant. What had simply been inferred in regard to the function of these organs in the three tuber-bearing species of *Anthoceros* previously known has now been observed in this Californian species.

DR. HENRY KRAEMER: *Morphology of the Genus Viola.* — About 30 species of violets, chiefly from the United States, have been examined with special reference to style and stigma, stamen spur, size and shape of the pollen grains, hairs upon the stamens and petals, presence of bracts, mucilage cells, etc. The paper, which represents a large amount of painstaking work, was illustrated by many drawings, photographs, and photomicrographs.

Bracts with characteristic mucilage-secreting hairs occur in all of the species, and sub-epidermal mucilage cells are present in the leaf, stem, and all parts of the flower except the stamens.

A number of species agree in having a nearly globular stigma with a more or less well developed lip-like appendage, a style with a geniculate bend in the lower part, and corkscrew-shaped hairs on the spurred petal. This group includes *Viola heterophylla*, *V. lutea*, *V. tricolor*, and varieties. In the remaining species the stigma is straight or somewhat globular and is destitute of any lip-like appendage, the style is bent or straight, and if any hairs are present upon the petals, they are straight. This group may be further subdivided on the length of the nectar-secreting stamenspur as follows:

(1) Spur shorter than the anther cells. — *V. blanda*, *V. primulæfolia*, *V. lanceolata*, *V. palustris*, *V. renifolia*.

(2) Spur of the same length as the anther cells and extending between them. — *V. rotundifolia*, *V. canadensis*, *V. nuttallii*, *V. hastata*, *V. pubescens*, *V. scabriuscula*, *V. tripartita*.

(3) Spur extending 1.5 to 1.8 mm. below the anther cells. — *V. pedata*, *V. ovata*.

(4) Spur extending 2.3 to 3.6 mm. below the anther.
    (*a*) Spur 0.78 mm. wide. — *V. arenaria*, *V. labradorica*, *V. striata*, *V. selkirkii*.
    (*b*) Spur 1.5 to 1.8 mm. wide. — *V. delphinifolia*, *V. odorata*, *V. obliqua*, *V. palmata*, *V. sagittata*, *V. sororia*.

(5) Spur extending 9 mm. below the anther. — *V. rostrata*.

Whether these 30 are all good species or partly varieties or hybrids is not yet certain. Color in some species has been shown to depend on climate, and the same is true of caulescence and acaulescence. The pollen is much alike in all. In some cases systematists appear to have mistaken germinating pollen grains for hairs in the bottom of the flower. The shape of the mucilage cells may possibly turn out to be of some help in classification. They are readily stained in a solution of methylene blue. The author would be glad to monograph this genus, if material could be obtained. He desires fresh seeds of Viola from all parts of the world. His address is Philadelphia College of Pharmacy, Philadelphia, Penn.

DR. G. E. STONE: *The Influence of Electricity upon Plants.* — Various kinds of currents were employed and data showing the relative effect of each upon the growth of the plant were presented, also the effect of single stimuli for a period of one minute, hourly intermittent and constant stimuli were shown. A brief *résumé* of some of the more important results obtained by subjecting about 20,000 plants to electrical stimuli are as follows:

(1) The application of certain strengths of current for a short period of time (one minute or less) is sufficient to act as a stimulus.

(2) The process of germination is accelerated by electricity.

(3) Electrical stimuli give rise to an acceleration in the growth of the plant.

(4) Electrically stimulated plants do not respond immediately to the influence of the current. The latent period following stimulation is equal to about 25 minutes, or, in other words, it is about the same as that for heliotropic and geotropic stimuli.

(5) The reaction of the plant to electrical stimulation is confined to a narrow range in the current intensity. The plant reaction is manifested either in an acceleration or retardation of its metabolic activities; the nature of the response depends entirely upon the nature of the strength of the current employed.

(6) There is a minimum, optimum, cessation, and maximum stimulus.

(7) The excitation produced by alternating currents is more marked than that produced by direct currents.

(8) The increase of stimulus necessary to produce an equally noticeable difference of perception bears a constant ratio to the total stimulus intensity; the relationship existing between the perception and stimulus is expressed by the ratio 1:3 (Weber's law).

DR. C. O. TOWNSEND: *Germination of Spores after Long Exposure to Distilled Water.* — Spores of Mucor, Penicillium, and other fungi were placed in test-tubes which had been partly filled with distilled water. Some of the test-tubes were placed in the open air so that the spores were subjected to the changes in temperature incident to the changes of weather from day to day as well as to the changes in temperature between day and night. Other test-tubes were kept at a nearly constant temperature of 18° in diffused light; others at the same temperature were kept in the dark, and still others at 25° in the light. The vitality of these spores was tested from time to time by placing them upon a gelatine-sugar mixture in damp chambers. So long as the spores, which were exposed to external conditions, did not freeze, they retained their ability to germinate in the usual time — from 12 to 16 hours. After they had been frozen, however, they did not germinate under the conditions used. The other spores under investigation retained their ability to germinate for about six months. The time required for germination after the spores were placed upon the gelatine-sugar mixture did not materially change during this period. It should also be noted that the growth of the mycelia, as well as the ability of the fungi to form new spores, did not vary in any marked degree from the growth and spore development of dry spores.

DR. ERWIN F. SMITH: *Sensitiveness of Certain Parasites to the Acid Juices of the Host Plants.* — The author presented a tabular statement of the results obtained by inoculating acid nutrient solutions with bacteria parasitic to plants, *e.g.*, *Pseudomonas campestris*, *Ps. phaseoli*, *Ps. hyacinthi*, *Ps. stewarti*, *Bacillus amylovorus*, *B. oleæ*, etc. He was led to these studies by observing that the three yellow plant parasites first named spread very slowly through the parenchymatic tissues of their host plants. This is true in the field and in the greenhouse, and it also occurs when enormous numbers of the organism are injected into the parenchyma by means of hypodermic syringes. To fully realize the slow progress of these diseases they should be compared with such rapid diseases as pear blight, the brown rot of the potato, or the soft white rot of hyacinths, which often destroy large portions of the host in a few days. Two of these yellow organisms are vessel parasites, their entrance into the plant being favored by the alkaline juice of the ducts. In all three the restraining influence was believed to be, in great part, at least, the acid juice of the parenchyma. The detailed experiments confirm this view and show that there is a very wide difference in the susceptibility of bacteria to plant acids. All of the solutions were titrated with $\frac{N}{10}$ NaOH and phenolphthalein, so that their exact acidity is known. Those who wish details are referred to a forthcoming bulletin on the pathogenic properties and life history of *Ps. hyacinthi*, of which this paper will form a part.

DR. CARLETON C. CURTIS: *Further Observations on the Relations of Turgor to Growth.* — Experiments were undertaken to determine (1) how soon growth would be renewed after a change in the concentration of the nourishing solution, and (2) to measure the turgor force at the moment of renewed growth. Three species of fungi were used — a Penicillium, a Mucor, and a Botrytis. These plants were grown in nourishing solutions and in the same with addition of 4, 9, 14, and 20 per cent nitrate of potash. Penicillium grown in the nourishing solution had a turgor force of 7.5, nitrate of soda being used as a plasmolyzer; when grown in 20 per cent nitrate of potash, it had a turgor force of 42.5. When transferred from the nourishing solution to the 20 per cent solution, growth was stopped from 8 to 12 hours. At renewal of growth the turgor was found to be normal for the 20 per cent solution, *i.e.*, 42.5. In changing from 20 per cent to 0, solution growth ceased, to be renewed again in 30 to 45 minutes. On this renewal of growth the turgor force was found to be normal for the 0 solution, *i.e.*, 7.5. Corresponding results were obtained with the weaker solutions. Thus, in changing from 0 to 4 per cent, recovery was effected in about 1 hour, the turgor force being 12, *i.e.*, normal for hyphæ growing in such a solution. In changing from 4 to 0, growth was renewed after about 15 minutes. Botrytis gave practically the same results. Mucor was much more sensitive. It has a lower turgor force and would not stand a change higher than a 4 per cent solution. In other respects it behaved like Penicillium and Botrytis. When nitrate of potash is used, turgor would seem to be a controlling force in growth. The checking of growth when the turgor is increased, as by change from a strong to a weak solution, corresponds to injury from cutting, *i.e.*, is in the nature of a shock, the length of time growth is inhibited depending on its severity.

DR. W. F. GANONG: *Some Appliances for the Elementary Study of Plant Physiology.* — The author pointed out that investigation is indirectly aided by good elementary teaching, which diffuses its results and enlists sympathy and support, and as well attracts more and better students for the making of investigators. At the present time, too, there is a rapidly increasing tendency to introduce more physiological study into elementary courses in schools and colleges, which is producing a demand for simpler and less expensive physiological appliances. In elementary teaching it is qualitative results that are mainly sought, and hence much simpler and less exact appliances can be used than is possible in investigation where nothing less than the very best can profitably be employed. The author then exhibited and described some simple appliances developed in his physiological practicum in Smith College. These included a simple temperature stage, made of copper; an efficient clinostat ample for demonstrating the principles of geotropism, heliotropism, etc., constructed from clockwork; a simple and inexpensive self-recording Auxanometer; an Osmometer made from burettes and Schleicher and Schuell's diffusion shells; a very simple apparatus for demonstrating the exchange of gases in respiration; a special germination box; an advantageous method of preparing a potted plant for the study of transpiration, and a simple method of graduating roots, etc., with insoluble India ink, which is applied on a stretched thread along which it runs by capillarity.

PROF. D. T. MAC DOUGAL: *Symbiosis and Saprophytism.* — It is customary to designate all chlorophylless, seed-forming plants, which have no nutritive connection with other vascular species, as saprophytes, or more exactly as holosaprophytes (allotropic or heterotropic forms, according to Pfeffer's classification), and others of similar physiological tendencies as hemisaprophytes (mixotropic forms), without regard to the nutritive unions formed by the roots or absorbing organs, as in mycorhiza, tubercles, and other associations. It is obvious that the terms *saprophyte* and *holosaprophyte* should be applied to those species only which derive their food supply from organic products directly without the activity of chlorophyll and unaided by other organisms. In this sense, which appears to be the only meaning admissible, the holosaprophytes include numerous bacteria and fungi, but, so far as previous investigations show, only one seed-forming genus, Wullschlægelia. As the result of some work now in press, the waxy white orchid of the northwest, *Cephalanthera oregana* Reichenb., should be added to this category.

As a consequence of the acceptance of the limitation of the term holosaprophyte, as given above, all those species furnished with mycorhiza or tubercles, or which enter into direct mechanical or nutritive associations, must be classed as symbionts.

It is a matter of common knowledge that seedlings are holosaprophytic in the stage in which they are wholly dependent upon the reserve material in the endosperm, and, in general, during the period previous to the formation of chlorophyll. This period is practically obliterated in those species in which chlorophyll is formed in the seed. The capacity for the absorption of humus products has played an important part in the production of the minute seeds of the orchids and other groups of similar physiological organization, and the extension or retention of this capacity throughout a greater or less portion of the life of the sporophyte has resulted in varying stages of true saprophytism. Although, so far as known, this period has been extended to include the complete life history of this generation in only two seed-forming genera, the results of recent investigations show that practically all green plants are capable of taking up and using a varying proportion of humus products. Only those which show a marked extension of this capacity should be classed as hemisaprophytes. The hemisaprophytes among seed-forming plants would therefore consist chiefly of carnivorous species, whereas nearly all of those now included are, in fact, more or less symbiotic by means of mycorhiza, tubercles, etc.

PROF. D. T. MAC DOUGAL: *Influence of Inversions of Temperature and Vertical Air Currents upon the Distribution of Plants.* — The soil and the air resting upon it receive the same amount of heat during the day, but at sunset the temperature of the earth is slightly higher than that of the air. At this time both begin to lose heat, but the soil cools much more rapidly than the air. The air is a poorer conductor than the soil, and hence the layers of air resting immediately upon it are cooled by radiation and conduction to the cold surface to a temperature far below that of the body of the air a few meters above. The consequences of this inversion are to be seen in the effects of late spring frosts, when the lower branches of a tree or shrub may be injured while the upper ones will be unharmed.

This nocturnal inversion of temperature occurs over almost all land areas, but is most marked in regions of low relative humidity. In North America it is most pronounced on the elevated plains, where it is a distinct but heretofore unrecognized factor in determining the boundaries of life zones.

In broken countries the cooling of the surface layers of air results in its contraction and increase in weight, and, as a consequence, the cold air thus formed on elevated mesas, ridges, and hilltops flows down the slopes into the depressions and valleys, filling the latter with a deep layer of cooled air while a constant supply of warm air settles down on the highlands. As a result of this action, the hills and lower mountain ridges have a much more equable temperature than the valleys and cañons. Thermographic records obtained at Flagstaff, Arizona (in a valley 6862 feet above sea level), and on Observatory hill (on the west side of the valley at an elevation of 7162 feet), in June and July, 1898, show that the minimum temperature of the valley was 15° to 27° F. lower than that of the hill at the same time.

If the slopes of the hill or mountain are several thousand feet in vertical extension, the descending current may sweep down so rapidly as to actually increase in temperature and reach the valley below as a warm wind. Regular currents of this sort are rare. The "Chinook" or "Foehn" owes its warmth to this cause.

Again, the upward movement of the air, under the influence of the sun's rays during the day, results in an expansion and absorption of some of the heat, so that these currents reach the highlands at a lower temperature than the air resting on such areas, and tend to an equalization of the temperature. At the stations mentioned, the maximum temperature of the hill was always 4° to 6° F. below that of the valley. Thus the total daily variation on the hill was 20° to 30° F. less than that of the valley.

Now, the northern advance of southern plants is governed by the sum of the positive temperatures, or the sum of the temperatures, above that at which plants and animals start into activity in the spring, taken throughout the entire season of growth and reproduction; and the southward distribution of northern plants is governed by the mean temperature of a brief period of a few weeks during the hottest part of the summer. It is obvious, therefore, that, as the positive temperature of the hills and mesas is greater than that of the valleys, the southern plants should find their way farthest north along the minor ridges and hills. At the same time the average temperature of the valleys is lower than that of the ridges, and hence the northern flora should reach its southernmost limits down valleys heading up in mountains and mesas favorable to the development of the greatest effects of inversions of temperature.

The influence of inversions of temperature is, therefore, to make extremely sharp deflections of the zonal boundaries, which may extend only a short distance locally, or which may reach over a hundred kilometers from the general limits of the zone. This conclusion is supported by my own observations in Arizona, and by facts concerning the flora and fauna of New Mexico and Texas cited by Professor Townsend.

Ascending currents of air also cause changes in humidity which exercise an extremely local influence on the distribution of the moisture-loving forms. As the diurnal warm current ascends the slope of a hill or the walls of a cañon, it expands and loses heat, and at the same time the dew point is lowered or the relative humidity is increased. When the current reaches the level of the highland it flows over it as a moist and cool wind. It is gradually warmed again, however, and its dew point raised in a few kilometers, progress. As a result of this action the area bordering upon a cañon, gulch, or valley offers a much more humid atmosphere than regions more removed, and hence these portions are most suitable for the moisture-loving species.

This principle is beautifully illustrated by the distribution of *Razoumofskya vaginata* (Willd.) Kuntze, which is parasitic on *Pinus ponderosa* var. *scopulorum* in this region. Although native of a semi-arid region, the parasite is most successful in the germination of its seeds and the attachment of the seedlings to the host plant in a humid atmosphere. While it is found throughout the pine belt, it is most abundant along the margin of mesas, and along hills bearing a certain topographic relation to adjoining valleys. The most striking example of this fact is to be seen along the mile-deep cañon of the Colorado river. Here the heated air rising from the river bed, under the rays of a sub-tropical sun, loses 20° F. of heat in its vertical ascent of over a kilometer. As a consequence it pours over the rim of the mesa heavily laden with moisture, and the Razoumofskya is quite abundant in a belt a kilometer in width running parallel to the rim, while it is comparatively infrequent at greater distances from the cañon.

PROF. CONWAY MAC MILLAN: *Notes on the Reproduction and Development of Nereocystis.* — The author described the great bladder kelp, *N. Lütkeana*, which is abundant in the swift tide-water channels of Puget sound, and which frequently reaches the enormous length of 80 to 100 meters. He has studied several hundred specimens (collected by Miss Josephine Tilden) with special reference to structure and early stages of growth. He exhibited a plant less than 1 millimeter long, and also one about 10 meters long. The latter consisted of a hollow green stem several centimeters in diameter at the base where it was anchored to the mud or rocks by a mat of large branched rhizoids, about 2 decimeters broad. This green stem gradually enlarged, until, at a distance of about 3 meters from the rhizoids, it very gradually expanded into a bulb 8 or 10 centimeters in diameter. This was crowned by the broad, thin, and very long, floating green laminæ. The figure given in *Die Natürlichen Pflanzenfamilien* is not a very good one. At low tide the sea is dotted with these floating bulbs, and the plants are so strong, in mass, that fishing boats may be anchored to them, while smaller boats are sometimes capsized by them. As is well known, the Aleuts formerly used the flexible hollow stem to siphon water from their boats.

Spores in sporangia are the only known reproductive bodies. Calosities occur on old plants. Sieve tubes are present. They are pulled out by the elongation of the stem, and are undoubtedly converted into gelatin. They are morphologically different from trumpet hyphæ. No evidence of protoplasmic connections was obtained. The cryptostomata disappear on old plants. The cleft in the lamina arises not as a tear, but is started by the deliquescence of a single row of cortex cells just below the epidermis. As the result of this continued deliquescence an ever deepening fold arises which finally cuts the lamina into two. Many slides, specimens, photographs, and drawings were exhibited.

DR. E. A. BURT: *The Formation and Structure of the Dissepiment of Porothelium.* — The author traced the development of the fructifications of *Porothelium fimbriatum* Pers. from their origin as papillæ, through the pore, to the tube stage, in the latter stage contrasting the structure of the dissepiment where the tubes are closely crowded together with its structure where they are more scattered.

This fungus occurs as a thin, closely adhering layer on dead limbs, etc. The papillæ are solid throughout their early history. They develop into pores by the more rapid growth of some parts than of others. In some species, as *P. friesii*, the papillæ are buried; in others, regarded as higher in rank, the papillæ are buried only in early stages of growth.

DR. ERWIN F. SMITH: *Gelatin Culture Media.* — By means of a chart, photographs, and paintings the author called attention to the diverse and confusing results different individuals working with the same organism might reach with gelatin culture media. Our knowledge of this very useful medium has increased greatly in recent years. The best paper in English is by Geo. S. Fuller, "On the Proper Reaction of Nutrient Media for Bacterial Cultivation," *Journal of the Am. Public Health Association*, October, 1895, Concord, N. H. The most confusing things are: (1) the fact that gelatin which reacts neutral or moderately alkaline to litmus is still acid to phenolphthalein and often exerts a restraining influence on bacteria, especially certain parasites; and (2) the fact that grape sugar or cane sugar in gelatin, while stimulating growth, often entirely prevents liquefaction, so that one may be dealing with a liquefying organism without knowing it. Some liquefiers are more sensitive than others, and it is not yet known how small an amount of sugar will restrain the most sensitive forms.

All gelatin media should be rendered neutral to phenolphthalein, and it would be well, for the present at least, to use beef broth free from muscle sugar in making gelatin. Possibly the restraining influence of sugar may also be of some use in making gelatin plate cultures of slow-growing forms which are mixed with rapid liquefiers, and which under ordinary circumstances run over and spoil the plate before the desired form has been able to grow.

All gelatin media should be titrated against $\frac{1}{10}$ or $\frac{1}{20}$ normal caustic soda, and then the desired amount of acid or alkali added in the form of double normal solutions so as not to much disturb the proportion of fluids and solids. The melting point depends on the amount of gelatin added, the length of the steamings, and the amount of acid or alkali added. All of these disturbing influences should be taken into account. The per cent of gelatin used and the melting point of the prepared media should always be stated.

Working with gelatin of varying grades of acidity and alkalinity, prepared according to Fuller's scale, *e.g.*, with + 50 + 40 + 30 + 20 + 10. 0 — 10 — 20 — 30 — 40 — 50, with interpolations and extension of the scale, if necessary, it is possible to obtain curves of growth decidedly different for different species, even those which are morphologically much alike and which behave the same on nutrient agar. On this scale the + signs indicate acidity and the — signs alkalinity, and the figures denote, per liter of nutrient gelatin, the number of cubic centimeters of the normal acid or alkali which would have to be added to render the medium exactly neutral to phenolphthalein. The litmus neutral point of gelatin is approximately + 25 of this scale. The varying behavior of *Pseudomonas campestris* in the same gelatin with different quantities of caustic soda is shown on the accompanying plate.

PROF. CHARLES E. BESSEY: *Relative Infrequence of Fungi upon the Trans-Missouri Plains and the Adjacent Foothills of the Rocky Mountain Region.* — A study of the fungus flora of the Trans-Missouri Plains, extending over a period of fourteen years, has shown that while the number of species is large the number of individuals is relatively small. This is in marked contrast to the flowering plants, where the number of individuals is relatively high as compared with the number of species, especially in the herbaceous groups.

Of the principal groups of fungi, the Phycomycetes are usually quite infrequent, appearing in considerable numbers in wet years only; the Perisporiaceæ are, likewise, not usually abundant, although occasionally becoming very abundant, as with the Phycomycetes; the Pyrenomyceteæ are numerous as to species, but ordinarily infrequent as to individuals, with, however, some marked exceptions, as the ergot of Agropyron and Elymus (*Claviceps* spp.); the Discomyceteæ are rare, excepting in the most favorable of seasons; the Uredineæ are usually abundant, although the number of species is not exceptionally large; the Ustilagineæ are not numerous in species nor commonly abundant in individuals, excepting for three or four which affect the cultivated cereals; of the "Fungi Imperfecti" the number of species is relatively large, while again the individuals are relatively infrequent.

The higher fungi, including the Basidiomyceteæ, show this infrequence of individuals still more emphatically; the Gasteromyceteæ are ordinarily infrequent, with now and then an exception, in favorable periods, as when *Ithyphallus impudicus* springs up in great abundance; the Hymenomyceteæ are normally rare, although the number of species is fairly large.

Apparently this relative infrequence of the fungi is due to the greater aridity of soil and air, resulting in less favorable conditions for the germination of the spores, as well as for the subsequent development of the plants themselves.

B. M. DUGGAR AND F. C. STEWART: *Different Types of Plant Diseases due to a Common Rhizoctonia.* — Rhizoctonia was established by De Candolle, in 1815, as a generic name for certain sterile fungi. Many species have since been described, all of which may be subterranean parasites. There is no certain evidence connecting these forms with fruiting stages. Studies in plant diseases during the past few years have brought together some very different types of disease due to Rhizoctonia, viz.: (1) damping off of seedlings of many kinds; (2) a rot of radishes; (3) a root-rot of beets; and (4) a stem-rot of carnations. Experiments have proved conclusively that the root-rot of the beet and the stem-rot of the carnation are interchangeable, and indicate that the sterile damping off fungus is also very probably the same species slightly modified physiologically. Under certain conditions Rhizoctonia forms sclerotia on the host (carnation) and also on culture media. On the beet brown mycelia but no sclerotia develop. The mycelium is peculiar in its method of branching, and in the formation of certain hyphal elements which function as spores. The germ tubes of these nearly iso-diametric elements often bore through the septa of empty cells to which the germinative cells are still attached. The fungus grows well in acid media, but is very sensitive to alkaline media, and this suggests methods of treatment, *i.e.*, by liming the soil. The similarity of all of the forms studied suggests that some other so-called species may likewise prove to be the same organism, and at present the plant cannot be referred to a definite species.

F. C. STEWART: *The Stem-Rot Diseases of the Carnation.* — Under the name "stem-rot" or "die back" at least two distinct diseases have been confused. One is caused by Rhizoctonia; the other is due to a Fusarium and is, perhaps, identical with Sturgis's carnation stem-rot. Both diseases are common in New York in the field and in the greenhouse.

The Fusarium attacks chiefly the stem and larger branches, discoloring the wood and killing the cortex. The stems rarely become soft rotten. The plants die gradually, with yellowing and drying of the foliage. The fungus fruits rarely on the outside of stems, but more frequently in the cambium and medulla of stems long dead.

The Rhizoctonia causes plants to wilt suddenly by rotting the stem at, or just below, the surface of the soil. The cortex readily separates from the wood. The medulla is attacked quite early, becoming water-soaked in appearance (or corky, when dry) and filled with hyphæ.